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CLAIMS:

What is claimed is:

1 1. A method of balancing path usage over a plurality of
2 paths from at least one first device to a plurality of
3 second devices, comprising:

4 determining a total path usage for each of the
5 plurality of paths; and

6 performing path balancing if a difference in a total
7 path usage of a path having a highest path usage and a
8 total path usage of a path having a lowest path usage is
9 greater than a threshold usage amount.

1 2. The method of claim 1, wherein the path balancing
2 includes:

3 identifying a highest path from the plurality of
4 paths, the highest path having a highest total path
5 usage;

6 identifying a lowest path from the plurality of
7 paths, the lowest path having a lowest total path usage;
8 and

9 calculating a difference between the total path
10 usage of the highest path and the lowest path to form a
11 calculated difference.

1 3. The method of claim 2, wherein each of the plurality
2 of second devices is associated with at least one of the
3 plurality of paths and wherein the path balancing

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4 includes moving a second device from the highest path to
5 the lowest path based on the calculated difference.

1 4. The method of claim 3, wherein the second device
2 remains unmoved if a number of moved second devices is
3 equal to or greater than a move limit.

1 5. The method of claim 3, wherein the second device
2 that is moved is the second device from the plurality of
3 second devices that has a usage amount closest to a
4 target amount.

1 6. The method of claim 5, wherein the target amount is
2 a fraction of the difference of the total path usage of
3 the highest path and the lowest path.

1 7. The method of claim 1, wherein the total usage for
2 each path is a function of the total usage for each
3 second device associated with each path.

1 8. The method of claim 7, wherein the total usage for
2 each second device is a function of a total number of
3 input/output messages directed to each second device
4 multiplied by the expected connect time for the
5 input/output messages.

1 9. The method of claim 8, wherein the expected connect
2 time for the input/output messages is based on the type
3 of input/output message being sent.

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1 10. The method of claim 1, wherein determining a total
2 path usage for each of the plurality of paths includes
3 sampling a number of I/O messages issued over each of the
4 paths during a sampling period.

1 11. The method of claim 3, wherein moving the second
2 device from the highest path to the lowest path based on
3 the calculated difference includes changing address
4 information for the second device.

1 12. The method of claim 4, wherein the move limit is set
2 to one half the number of paths.

1 13. The method of claim 4, wherein if only one second
2 device is associated with the highest path, movement of
3 the one second device to the lowest path is prohibited.

1 14. A method of balancing communication path usage over
2 a plurality of communication paths from at least one open
3 system device to a plurality of peripheral devices,
4 comprising:

5 calculating a total path usage for each of the
6 plurality of communication paths;

7 identifying a highest communication path from the
8 plurality of communication paths, the highest
9 communication path having a highest total path usage;

10 identifying a lowest communication path from the
11 plurality of communication paths, the lowest
12 communication path having a lowest total path usage;

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13 calculating a difference between the total path
14 usage of the highest communication path and the lowest
15 communication path to form a calculated difference; and
16 moving a peripheral device associated with the
17 highest communication path from the highest communication
18 path to the lowest communication path based on the
19 calculated difference.

1 15. The method of claim 14, wherein the peripheral
2 device remains unmoved if a number of moved peripheral
3 devices is equal to or greater than a move limit.

1 16. The method of claim 14, wherein the peripheral
2 device that is moved is the peripheral device from the
3 plurality of peripheral devices that has a usage amount
4 closest to a target amount.

1 17. The method of claim 16, wherein the target amount is
2 a fraction of the difference of the total path usage of
3 the highest communication path and the lowest
4 communication path.

1 18. The method of claim 14, wherein the total usage for
2 each communication path is a function of the total usage
3 for each peripheral device associated with each
4 communication path, respectively.

1 19. The method of claim 18, wherein the total usage for
2 each peripheral device is a function of a total number of
3 input/output messages directed to each peripheral device,

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4 respectively, multiplied by the expected connect time for
5 the input/output messages.

1 20. The method of claim 19, wherein the expected connect
2 time for the input/output messages is based on the type
3 of input/output message being sent.

1 21. The method of claim 14, wherein calculating a total
2 path usage for each of the plurality of communication
3 paths includes sampling a number of input/output messages
4 issued over the plurality of communication paths during a
5 sampling period.

1 22. The method of claim 14, wherein moving the
2 peripheral device from the highest path to the lowest
3 path based on the calculated difference includes changing
4 address information for the peripheral device.

1 23. The method of claim 15, wherein the move limit is
2 set to one half the plurality of communication paths.

1 24. The method of claim 15, wherein if there is only one
2 peripheral device associated with the highest path,
3 movement of the one peripheral device to the lowest path
4 is prohibited.

1 25. A computer program product in a computer readable
2 medium for balancing path usage over a plurality of paths
3 from at least one first device to a plurality of second
4 devices, comprising:

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5 first instructions for determining a total path
6 usage for each of the plurality of paths; and
7 second instructions for performing path balancing if
8 a difference in a total path usage of a path having a
9 highest path usage and a total path usage of a path
10 having a lowest path usage is more than a threshold usage
11 amount.

1 26. The computer program product of claim 25, wherein
2 the second instructions further include:
3 instructions for identifying the highest path from
4 the plurality of paths, the highest path having a highest
5 total path usage;
6 instructions for identifying the lowest path from
7 the plurality of paths, the lowest path having a lowest
8 total path usage; and
9 instructions for calculating a difference between
10 the total path usage of the highest path and the lowest
11 path.

1 27. The computer program product of claim 26, wherein
2 each of the plurality of second devices is associated
3 with at least one of the plurality of paths and wherein
4 the second instructions include instructions for moving a
5 second device from the highest path to the lowest path
6 based on the difference.

1 28. The computer program product of claim 25, wherein
2 the first instructions include instructions for sampling

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3 a number of I/O messages issued over each of the
4 plurality of paths during a sampling period.

1 29. The computer program product of claim 27, wherein
2 the instructions for moving the second device from the
3 highest path to the lowest path based on the calculated
4 difference includes instructions for changing address
5 information for the second device.

1 30. A path balancing apparatus that balances the path
2 usage over a plurality of paths from at least one first
3 device to a plurality of second devices, comprising:
4 a controller that accumulates a total path usage for
5 each of the plurality of paths; and
6 a path balancing device that performs path balancing
7 if a difference in a total path usage of a path having a
8 highest path usage and a total path usage of a path
9 having a lowest path usage is more than a threshold usage
10 amount.

1 31. The apparatus of claim 30, wherein the path
2 balancing device performs path balancing by:
3 identifying a highest path from the plurality of
4 paths, the highest path having a highest total path
5 usage;
6 identifying a lowest path from the plurality of
7 paths, the lowest path having a lowest total path usage;
8 and
9 calculating a difference between the total path
10 usage of the highest path and the lowest path.

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1 32. The apparatus of claim 31, wherein each of the
2 plurality of second devices is associated with at least
3 one of the plurality of paths and wherein the path
4 balancing device moves a second device from the highest
5 path to the lowest path based on the difference.

1 33. The apparatus of claim 32, wherein the path
2 balancing device does not move the second device if a
3 number of moved second devices is equal to or greater
4 than a move limit.

1 34. The apparatus of claim 32, wherein the second device
2 that is moved by the path balancing device is the second
3 device from the plurality of second devices that has a
4 usage amount closest to a target amount.

1 35. The apparatus of claim 34, wherein the target amount
2 is a fraction of the difference between the total path
3 usage of the highest path and the lowest path.

1 36. The apparatus of claim 30, wherein the total usage
2 for each path is a function of the total usage for each
3 of the plurality of second devices associated with each
4 path.

1 37. The apparatus of claim 36, wherein the total usage
2 for each second device is a function of a total number of
3 input/output messages directed to each second device
4 multiplied by an expected connect time for the
5 input/output messages.

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1 38. The apparatus of claim 37, wherein the expected
2 connect time for the input/output messages is based on
3 the type of input/output message being sent.

1 39. The apparatus of claim 30, wherein the controller
2 accumulates a total path usage for each of the plurality
3 of paths by sampling a number of input/output messages
4 issued over each of the paths during a sampling period.

1 40. The apparatus of claim 32, wherein the path
2 balancing device moves the second device from the highest
3 path to the lowest path based on the calculated
4 difference by changing address information for the second
5 device.

1 41. The apparatus of claim 33, wherein the move limit is
2 set to one half the plurality of paths.

1 42. The apparatus of claim 33, wherein if there is only
2 one second device associated with the highest path,
3 movement by the path balancing device of the one second
4 device to the lowest path is prohibited.

1 43. A path balancing system in which path usage over a
2 plurality of paths from at least one first device to a
3 plurality of second devices is balanced, comprising:
4 first means for accumulating a total path usage for
5 each of the plurality of paths; and
6 second means for performing path balancing if a
7 difference between a total path usage of a path having a

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8 highest path usage and a total path usage of a path
9 having a lowest path usage is more than a threshold usage
10 amount.

1 44. The system of claim 43, wherein the second means
2 performs path balancing by:
3 identifying a highest path from the plurality of
4 paths, the highest path having a highest total path
5 usage;
6 identifying a lowest path from the plurality of
7 paths, the lowest path having a lowest total path usage;
8 and
9 calculating a difference between the total path
10 usage of the highest path and the lowest path.

1 45. The system of claim 44, wherein each of the
2 plurality of second devices is associated with at least
3 one of the plurality of paths and wherein the second
4 means moves a second device from the highest path to the
5 lowest path based on the difference.

1 46. The system of claim 45, wherein the second means
2 does not move the second device if a number of moved
3 second devices is equal to or greater than a move limit.

1 47. The system of claim 45, wherein the second device
2 that is moved by the second means is the second device
3 from the plurality of second devices that has a usage
4 amount closest to a target amount.

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1 48. The system of claim 47, wherein the target amount is
2 a fraction of the difference of the total path usage of
3 the highest path and the lowest path.

1 49. The system of claim 43, wherein the total usage for
2 each path is a function of the total usage for each
3 second device associated with each path.

1 50. The system of claim 49, wherein the total usage for
2 each second device is a function of a total number of
3 input/output messages directed to each second device
4 multiplied by the expected connect time for the
5 input/output messages.

1 51. The system of claim 50, wherein the expected connect
2 time for the input/output messages is based on the type
3 of input/output message being sent.

1 52. The system of claim 43, wherein the first means
2 accumulates a total path usage for each of the plurality
3 of paths by sampling a number of input/output messages
4 issued over each of the paths during a sampling period.

1 53. The system of claim 45, wherein the second means
2 moves the second device from the highest path to the
3 lowest path based on the calculated difference by
4 changing address information for the second device.

1 54. The system of claim 46, wherein the move limit is
2 set to one half the plurality of paths.

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- 1 55. The apparatus of claim 45, wherein if there is only
2 one second device associated with the highest path,
3 movement by the second means of the one second device to
4 the lowest path is prohibited.